AD-A063 511 GILBERT ASSOCIATES INC READING PA F/G 13/2
NATIONAL DAM SAFETY PROGRAM. HOGAN DAM (VA-15504), PULASKI COUN--ETC(U)
AUG 78 T ROBERTS DACW65-78-D-0014

UNCLASSIFIED NL

1 OF 1
AD
A063511

END
DATE FILMED
3--79
DDC

NEW RIVER BASIN

**Name Of Dam:** HOGAN DAM

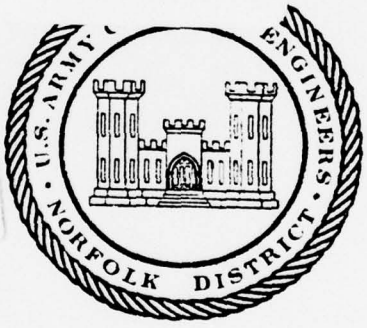
**Location:** PULASKI COUNTY, VIRGINIA

**Inventory Number:** VA 15504

# LEVEL II

# PHASE I INSPECTION REPORT
# NATIONAL DAM SAFETY PROGRAM








**PREPARED FOR**

**NORFOLK DISTRICT CORPS OF ENGINEERS**
**803 FRONT STREET**
**NORFOLK, VIRGINIA 23510**

**BY**

GILBERT ASSOCIATES, INC.

AUGUST, 1978



154 250

79 01 16 217

NATIONAL DAM SAFETY PROGRAM
PHASE I INSPECTION REPORT

REVISION NO. 2 TO HOGAN DAM

Delete recommendation No. 3 in brief assessment of dam.

Delete paragraph 7.2C.

REVISION NO. 1 TO PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

HOGAN

The cover color is revised to white. The actual cover will not be changed. Each recipient of a copy of this report should notate the existing cover. In addition, add to Section 7, the following paragraphs:

7.1.1 Using the Corps of Engineers screening criteria for initial review of spillway adequacy, it has been determined that the embankment would be overtopped for all storms exceeding approximately 33% of the PMF. The spillway is therefore, adjudged as seriously inadequate and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

7.2.1 In accordance with paragraph 7.1.1, it is recommended that within two months from the date of notification to the Governor of the Commonwealth of Virginia, the owner engage the services of a professional consultant to determine by more sophisticated methods and procedures the adequacy of the spillway. Even though the seriously inadequate spillway would produce a dam failure primarily from hydrologic reasons, remedial measures in structural or geotechnical areas may be needed to remove the dam from an unsafe classification. Within 6 months of the date of notification to the governor, the professional consultant's report of appropriate remedial mitigating measures should have been completed and the owner should have an agreement with the Commonwealth of Virginia to a reasonable time frame in which all remedial measures will be complete. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

# REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

| | |
|---|---|
| 1. REPORT NUMBER: VA 15504 | 2. GOVT ACCESSION NO. |
| 3. RECIPIENT'S CATALOG NUMBER | |
| 4. TITLE (and Subtitle): Phase I Inspection Report<br>National Dam Safety Program<br>Hogan Dam<br>Pulaski County, Virginia | 5. TYPE OF REPORT & PERIOD COVERED: Final |
| | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s): Gilbert Associates, Thomas Roberts<br>Reading, PA | 8. CONTRACT OR GRANT NUMBER(s): DACW 65-78-D-0014 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>154850 | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS |
| 11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Engineering District, Norfolk<br>803 Front Street<br>Norfolk, VA 23510 | 12. REPORT DATE: August 1978<br>13. NUMBER OF PAGES: 43 |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) | 15. SECURITY CLASS. (of this report): Unclassified<br>15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams - VA
National Dam Safety Program Phase I
Dam Safety
Dam Inspection

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

(See reverse side)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

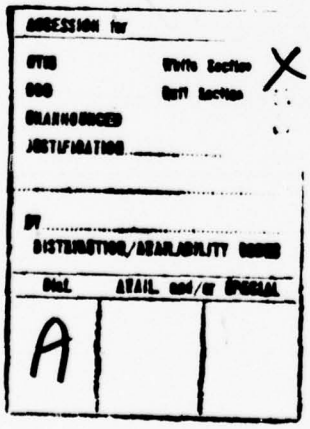
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. Abstract

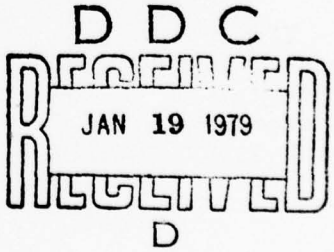
Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.




LEVEL II



PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

| | |
|---|---|
| Name of Dam: | Hogan |
| State: | Virginia |
| County: | Pulaski |
| USGS Quadrangle Sheet: | Pulaski |
| Stream: | Hogan Branch |

The Hogan Dam is a rockfill embankment 60 feet high and about 270 feet long. The dam has a concrete face and a 5.5-foot high concrete coping wall on the crest. A spillway approach channel and concrete crest are located in a cut through the right abutment. The dam serves as an auxiliary water supply for the town of Pulaski.

The dam is very old and little design or construction information is available. The only serious design deficiency revealed by this inspection is that the spillway capacity is only sufficient to pass a flood 33 percent of the probable maximum flood (PMF) and is, therefore, "seriously inadequate" according to the U.S. Corps of Engineers' criteria described in paragraph 5.8. The inadequacy of the spillway could be hazardous depending on conditions and requires immediate action by the owner. The PMF and one half PMF will overtop the dam by 3.7 feet and 1.5 feet, respectively. (See Appendix VI, Conditions)

The following recommendations are presented for the owner's consideration and implementation.

1. Develop, within 30 days, a detailed emergency warning system to notify the downstream area of impending danger, and determine those areas subject to inundation from a dam break flood wave.

2. Investigate the stability of the dam within 6 months.

3. Enlarge the spillway capacity to pass a PMF without overtopping the dam.

4. Establish a program to monitor conditions at the dam site at least semiannually.

5. Maintain a file of all available documents pertinent to the design, construction, and operation of the dam.

Until such time that the above recommendations can be implemented, during periods of heavy rains the owner should provide continuous surveillance of the dam and prepare to implement the warning system procedures recommended in paragraph 1. above.

Prepared by:


APPROVED: Original signed by:

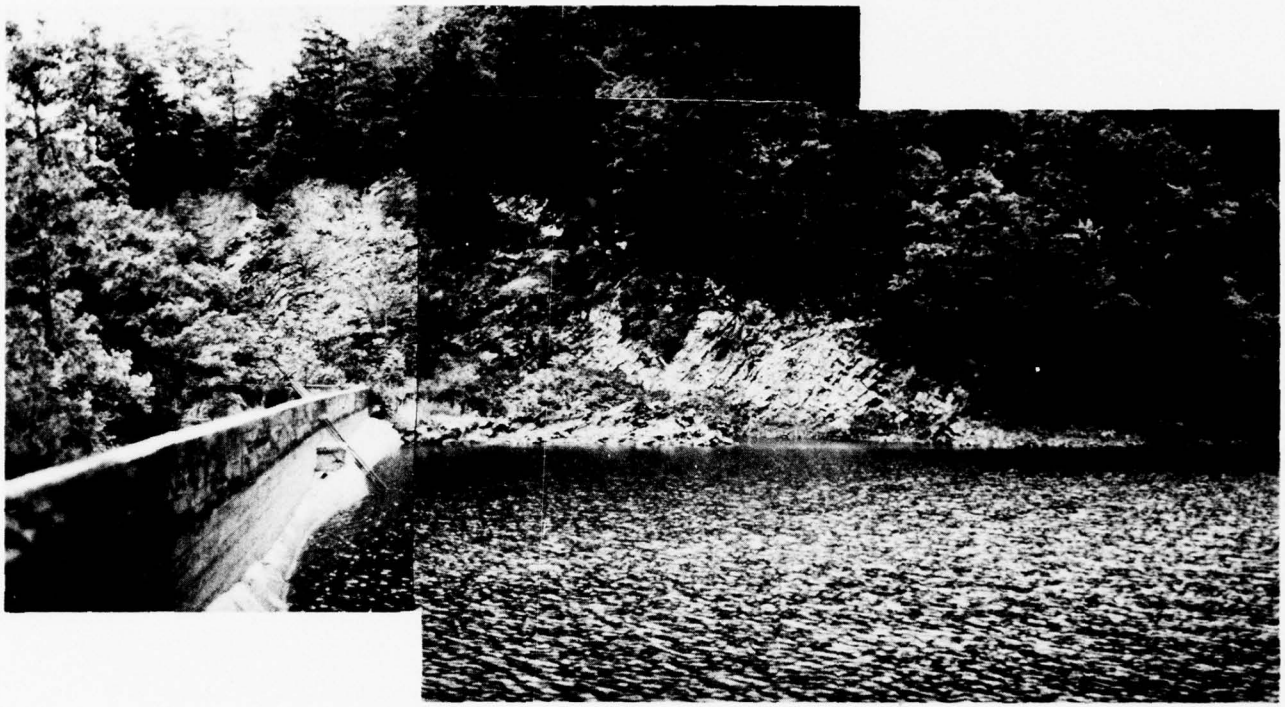
Douglas L. Haller

Douglas L. Haller
Colonel, Corps of Engineers
District Engineer

Date: 21 AUG 1978

Submitted By: Original signed by JAMES A. WALSH

Recomended By: Original signed by ZANE M. GOODWIN



May 1978

OVERVIEW
UPSTREAM FACE OF DAM FROM LEFT ABUTMENT. SPILLWAY CHANNEL ENTRANCE IS TO THE RIGHT.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: Hogan Dam I.D. #: VA 15504

## SECTION 1 - PROJECT INFORMATION

### 1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the U.S. Corps of Engineers to initiate a national program of safety inspections of non-Federal dams throughout the United States. The Norfolk District of the U.S. Corps of Engineers has been assigned the responsibility of the inspection of dams in the State of Virginia. Gilbert Associates, Inc. has entered into a contract with the Norfolk District to inspect this dam, Gilbert Work Order 06-7250-001.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 1 of Appendix V) and contract requirements between Gilbert Associates, Inc. and the Corps of Engineers. The objectives are to expeditiously identify whether this dam apparently poses an immediate threat to human life or property, and to recommend future studies and/or any obvious remedial actions that may be indicated by the inspection.

### 1.2 Project Description

1.2.1 Dam and Appurtenances: The dam is a rockfill embankment approximately 270 feet long and 60 feet high. The top of the embankment is 10 feet wide, and a 5.5-foot concrete wall is constructed upon the crest. The upstream slope is covered with a 12-inch concrete liner and stands at a 1 horizontal to 1 vertical slope. The downstream slope is at 1-1/4 horizontal to 1 vertical. The entire embankment has been grouted but there is no indication of a grout curtain or cutoff wall beneath the dam.

The essential features of the outlet system include a series of gated inlets at various levels of the reservoir connected by a network of pipes, a valve pit, and a bottom outlet which is on a separate pipeline. The five gated inlets are connected by 8-inch and 12-inch pipes. The pipelines all lead to the valve pit and are connected to a single 16-inch outlet pipe. Shutoff valves are located in the valve pit but the flow is controlled by leaf type gates on each inlet. The gates are operated by control mechanisms located on the crest of the dam.

The bottom outlet has a 16-inch pipeline which leads through the valve pit and discharges at the toe of the dam. A valve at the base of the valve pit regulates the flow and this valve is controlled by a chain drive

mechanism at the top of the valve pit. The valve pit has a 10-foot diameter and extends from the base of the dam to the crest.

The spillway is a chute type which serves as both the service and emergency spillway. It is carved out of the rock on the right abutment and consists of a level approach channel about 40 feet wide and 70 feet long, a concrete crest, and an exit channel which leads away from the dam and then plunges nearly vertically into the stream below. The spillway crest lies on the axis of the dam. It consists of a 4.7-foot wide concrete apron which slopes upward 0.6 feet and then drops 3.3 feet into the exit channel. Vertical concrete endwalls form the sides giving a total crest length of 36 feet.

1.2.2 Location: Hogan dam is located on Hogan Branch 2.3 miles southwest of the town of Pulaski, Pulaski County. The dam is located where Hogan Branch cuts through a small ridge identified as Caseknife Ridge.

1.2.3 Size Classification: The dam is classified as intermediate size based upon the height of the embankment (60 feet), according to the requirements of Section 2.1.1 of Reference 1 of Appendix V.

1.2.4 Hazard Classification: The dam is located in a lightly populated area, but is on a tributary to Peak Creek which runs directly through the town of Pulaski. The chance for the loss of some lives and excessive community economic loss in the postulated event of dam failure call for a high hazard classification, according to the requirements of Section 2.1.2 of Reference 1 of Appendix V. The hazard classification used to categorize dams is a function of location only and unrelated to the stability or probability of failure.

1.2.5 Ownership: The dam is owned by the town of Pulaski, Virginia.

1.2.6 Purpose: The reservoir is used to augment the primary water supply of the town.

1.2.7 Design and Construction History: The dam was constructed in the early 1900's; the exact year is uncertain. It has since undergone several revisions. Originally the dam was built to approximately elevation 2150 feet. It was raised sometime prior to 1926 by enlarging the embankment to about elevation 2158 feet. In about 1946 it was raised again through the addition of a concrete parapet wall to approximately elevation 2162 feet. Recently, sometime between 1970 and 1972, the spillway was lowered to the present level (elevation 2153.4 feet m.s.l.), as it existed prior to 1946. In about 1946 the entire embankment was grouted. However, information is not available regarding how the grouting was conducted, i.e., hole spacings,

depths, quantity of grout takes, etc. The names of the various contractors are not known but the name of S. B. Williamson appears on some 1926 engineering drawings and the name of H. C. Jackson on some 1946 drawings.

1.2.8 Normal Operating Procedure: Although the dam is a part of the city's water supply, it is not in active use. When needed, water is released into the channel below the dam where further downstream it is pumped out of the river into the treatment plant. Normally all outlets are closed and water is allowed to pass over the spillway into the spillway channel.

1.3 Pertinent Data

1.3.1 Drainage Area: 2.66 square miles

1.3.2 Discharge at Dam Site:
Maximum historic flood at dam site not known.

Spillway:

Pool level at top of dam ..... 2,800 c.f.s.
Pool level with three feet of freeboard ... 1,400 c.f.s.

Bottom Outlet:

Pool level at spillway crest ..... 43 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data is summarized in Table 1.1.

Table 1.1 DAM AND RESERVOIR DATA

| Item | Elevation feet m.s.l. | Reservoir Capacity Area acres | Reservoir Capacity Acre feet | Reservoir Capacity Watershed inches | Length miles |
|---|---|---|---|---|---|
| Top of Dam | 2162.4 | 41 | 1285 | 7.96 | 0.8 |
| Ungated Spillway Crest | 2153.4 | 37 | 934 | 6.58 | 0.8 |
| Streambed at Centerline of Dam | 2100± | - | - | - | - |

## SECTION 2 - ENGINEERING DATA

2.1 Design: No design information is available.

2.2 Construction: No construction information is available.

2.3 Operation: No records are kept.

2.4 Evaluation: There are several sketches of the dam made at the time when additional construction and previous inspections were performed. These are available from the town of Pulaski. There is probably more information in the files of local consultants, but it would take considerable time to research and assemble it. The sketches appear to reasonably coincide with structures and conditions observed, but there is very little firm data to evaluate.

## SECTION 3 - VISUAL INSPECTION

3.1 Findings: The visual inspection found several minor conditions and one more significant condition that requires attention as set forth below. The dam has been inspected twice in the last six years and most repairs and recommendations of the inspections appear to have been carried out. Copies of the prior inspection reports are included as Appendix IV.

The most serious visual finding was the seepage on the right abutment. The seepage was noted as early as 1970 but not considered serious by the previous inspectors because of the low flow rate then. In the 1977 inspection, the seepage was estimated at 1 to 2 g.p.m. The June 8, 1978 inspection (see Appendix III) estimated the seepage to be on the order of 20 g.p.m. The caretaker of the dam mentioned that the seepage had increased not long ago.

Some other minor visual findings were a tree growing on the crest of the embankment, concrete debris in the spillway channel, and some minor concrete weathering on the concrete wall. However, these items will not likely affect the integrity of the embankment or spillway.

3.2 Evaluations: Based on the June 8, 1978 visual inspection, there did not appear to be any conditions which indicate the dam was receiving poor care or presented an immediate hazard under normal conditions. The seepage does raise some concern if, as reported, it has increased. This situation should be monitored more closely in the future with some accurate flow measurements to notice any change.

## SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: The reservoir is not an active part of the town's water supply and there is no operational procedure except for upkeep maintenance as noted below.

4.2 Maintenance of Dam: Maintenance of the dam is carried out by the town of Pulaski, and a full time caretaker lives at the site. Inspections by local consulting engineers have been performed twice in the last six years.

4.3 Maintenance of Operating Facilities: Same as discussed in paragraph 4.2.

4.4 Warning System: None.

4.5 Evaluation: Because the dam is not an active component of the Pulaski water supply, there is no regular operating procedure. Maintenance appeared to be adequate for normal operation. The two inspections in the last six years by outside consulting engineers is a indication of the interest the town shows in the upkeep and integrity of the dam.

## SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: No data available.

5.2 Hydrologic Records: None

5.3 Flood Experience: The greatest depth over the spillway recalled by the caretaker (since 1960) was 12 inches. No flood records are kept.

5.4 Flood Potential: The flood potential of the dam was evaluated by calculating the probable maximum flood (PMF), one-half the PMF, and the 100-year flood, and routing each flood through the reservoir. The results of these studies are given in paragraph 5.6. These analyses pertain to present hydrologic conditions and do not consider future uncertain conditions, such as urbanization or other changes in the watershed.

5.5 Reservoir Regulation: None

5.6 Overtopping Potential: The PMF, one-half the PMF, and the 100-year flood hydrographs were developed for the Hogan Reservoir drainage basin and routed through the reservoir.

The hydrographs were developed and routed by using the HEC-1 computer program (Reference 2 of Appendix V) and appropriate precipitation, unit hydrograph, and storage volume versus outflow data as input. The triangular unit hydrograph was developed from the drainage area and an estimated time to peak (Reference 3 of Appendix V). Probable maximum precipitation and 100-year precipitation data were obtained from U.S. Weather Bureau publications (References 4 and 5 of Appendix V). Appropriate reduction factors were applied to the PMF in accordance with Corps of Engineers' directive and guidelines. Information was obtained from design drawings and flow over the spillway computed as flow over a broad-crested weir to produce the storage-outflow relation. Precipitation losses were estimated at an initial loss of 1.0 inch and a constant loss rate of 0.30 inch/hour. The results of these calculations are presented in Table 5.1.

The results of this study showed that the spillway capacity is only sufficient to pass 33 percent of the PMF before the dam is overtopped. The PMF overtops the crest by 3.7 feet and one-half the PMF by 1.5 feet.

5.7 Reservoir Emptying Potential: A volume-elevation curve was not available for the reservoir, so in order to estimate the hydraulic head on the outlet for any given remaining storage volume, the head was assumed

to vary as the cube root of the storage volume, being equal to the depth of the normal pool for a full reservoir and equal to zero for an empty reservoir.

The reservoir can be lowered by using the outlet works and a bottom outlet, both of which have a 16-inch diameter pipe. If both are assumed to be simple pipes with ordinary losses and if the complex geometry of the intake system is ignored, an estimated time to empty the reservoir is calculated to be about seven days. If only one system were operable, this time would be increased to 13 days.

Table 5.1 - RESERVOIR PERFORMANCE

| Item | Average Flow | Flood | | |
|---|---|---|---|---|
| | | One Percent (a) | 1/2 PMF | PMF (b) |
| Peak Discharge, c.f.s.: | | | | |
| Inflow - | | 3880 | 6480 | 13,000 |
| Outflow - | | 2090 | 5750 | 12,300 |
| Peak Elevation, feet m.s.l. | | 2161.0 | 2163.9 | 2166.1 |
| Ungated Spillway: | | | | |
| Depth at Crest, feet (c) | | 4.8 | 6.6 | 8.0 |
| Velocity at Crest, f.p.s. | | 12.1 | 14.6 | 16.1 |
| Depth of Flow, in Approach Channel | | 8.2 | 11.1 | 13.3 |
| Average Velocity, f.p.s. | | 4.9 | 5.3 | 5.5 |
| Non-overflow Sections: | | | | |
| Depth of Flow, feet (c) | | - | 1.0 | 2.5 |
| Average Velocity, f.p.s. | | - | 5.7 | 8.9 |
| Duration, hours | | - | 1.7 | 4.3 |

Notes:

(a) The 1 percent exceedence frequency flood has one chance in 100 of being exceeded in any given year.

(b) The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

(c) Critical depth.

5.8 Evaluation: The screening criteria for assessing the adequacy of the spillway design flood allow essentially no risk of loss of life from dam failure by overtopping. Experience indicates that very few existing non-Federal dams were designed with such conservative criteria. Therefore, the Phase I inspection findings will indicate noncompliance with the spillway design flood screening criteria for most non-Federal dams. In accordance with the U.S. Corps of Engineers' Engineer Technical Letter No. 1110-2-234, a further classification is required based upon the percent of the PMF passed by the spillway before overtopping occurs, and the consequences of the dam being overtopped and failing. Based upon these criteria, the spillway may be further classified as "seriously inadequate."

The spillway capacity was calculated at approximately 33 percent of the PMF. Based upon the inspection guidelines described above, the spillway is considered "seriously inadequate." Because the embankment consists of a rock fill, it may be able to withstand a certain amount of overtopping without failure. If the owner can demonstrate that the dam can withstand overtopping by the one-half PMF, the spillway classification could be reduced to "inadequate." A seriously inadequate spillway requires immediate attention.

The PMF will overtop the dam by 3.7 feet for a duration of 4.3 hours. The one-half PMF will overtop the dam by 1.5 feet for 1.7 hours.

## SECTION 6 - DAM STABILITY

6.1 Stability Analysis: Neither any record of the stability analysis, if carried out, nor adequate information to carry out such an analysis for this dam is available. It is not known how the grouting was done in 1946, or why it was done. However, no sign of any failure of either the upstream slope or the downstream slope, or any significant deformation of the embankment, was noticed during the visual inspection. Also, there apparently is no evidence that such a failure or deformation occurred since the dam was raised, that is, at least since 1926. Thus, the dam may be considered to be in a stable condition. However, further investigation is required to examine the internal conditions of the dam and to verify that the dam would be adequately stable under anticipated worst conditions of loading as specified in the U.S. Corps of Engineers' Recommended Guidelines (Reference 1 of Appendix V). The investigation should include determination of the constituent dam materials and their properties, foundation conditions, and static stability analyses for the anticipated loading conditions.

6.2 Foundation and Abutments: The October 1972 inspection report by Wiley & Wilson (Appendix IV) refers to a May 1970 report by Dr. Cooper in which an area on the right abutment (now submerged) is identified as contorted and fractured. This area is evidently the source of seepage identified earlier in this report. Dr. Cooper's recommendation was to cover the area with a concrete blanket. Wiley & Wilson proposed that grouting could be performed if, after some other modifications to the spillway, the seepage still looked serious.

Bedrock at the dam is composed of sandstones, siltstones and shale. Solutioning of the bedrock by leakage would not be significant for such rock types.

6.3 Evaluation: The dam presently appears to be in a stable condition. However, further investigations as stated in paragraph 6.1 are required to verify the adequacy of its stability during anticipated worst conditions of static loading. Also, the presently occurring seepage at the right abutment needs to be watched.

The dam is located within Zone 2 of the Algermissen's Seismic Risk Map of the United States (1969 edition) and there are uncertainties with respect to the static stability of the dam, as described in paragraph 6.1. Therefore, in accordance with paragraph 3.6.4 of Reference 1 of Appendix V, assessments should be made regarding seismic stability, based on the studies outlined in paragraph 7.2.d.

## SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

The assessment, recommendations, and remedial measures contained in this Report are based on the provisions of Appendix VI, Conditions.

7.1 Assessment: There is no apparent structural deficiency in the dam and the maintenance is adequate. The major design deficiency is that the spillway capacity can pass only 33 percent of the PMF before the dam is overtopped. Therefore, based on the U.S. Corps of Engineers criteria described in paragraph 5.8 the spillway is "seriously inadequate." The recommended design flood is the PMF. The PMF will overtop the dam by 3.7 feet and the one-half PMF by 1.5 feet. The assessment of the dam is severely limited by the lack of detailed information concerning the construction and later repairs and additions to the dam.

7.2 Recommendations/Remedial Measures: The following actions are recommended for the owner's consideration to improve the safety of the dam:

a. Warning System: A detailed emergency warning system should be developed as soon as possible to notify the downstream inhabitants of an impending dam failure. In order for the warning system to be effectively applied, a study of the downstream area should be made so that the areas subject to flooding as a result of a dam break can be identified.

b. Inspection Program: It is recommended that the owner establish a semiannual inspection program to monitor the conditions at the dam. Particular attention should be given to monitoring the seepage on the right abutment.

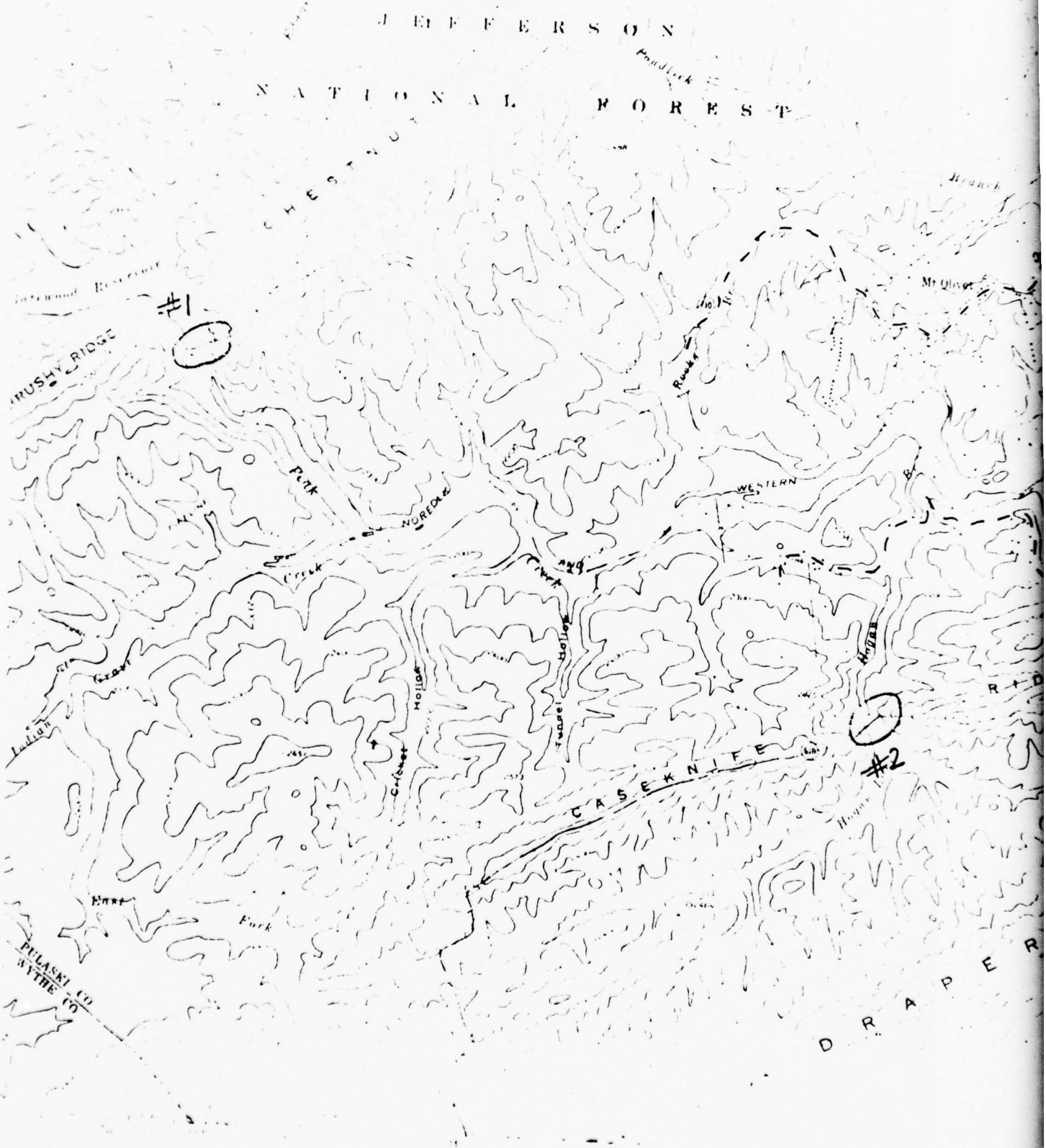
c. Increased Spillway Capacity: The owner should enlist the services of a qualified consultant to design a new spillway with capacity sufficient to pass the PMF without overtopping the dam. This work should be carried out within 120 days.

d. Stability: The owner should obtain the services of a qualified consultant to investigate the stability of the embankment as stated in paragraph 6.1. Particular attention should be given to the effects of an overtopping of the dam on the hydrostatic pressures within the embankment. These tasks should be carried out within 180 days.

e. Design Documents: A complete set of all available design documents should be maintained by the owner. These files should include available design drawings, calculations, pertinent correspondence, and maintenance records. In addition, an attempt should be made to obtain all available information on past design changes and repairs to the dam and the reasons for the changes.

# APPENDIX I

## MAPS AND DRAWINGS


JEFFERSON
NATIONAL FOREST
#1
#2
BUSHY RIDGE
CASEKNIFE
WESTERN
PULASKI CO
WYTHE CO
DRAPER

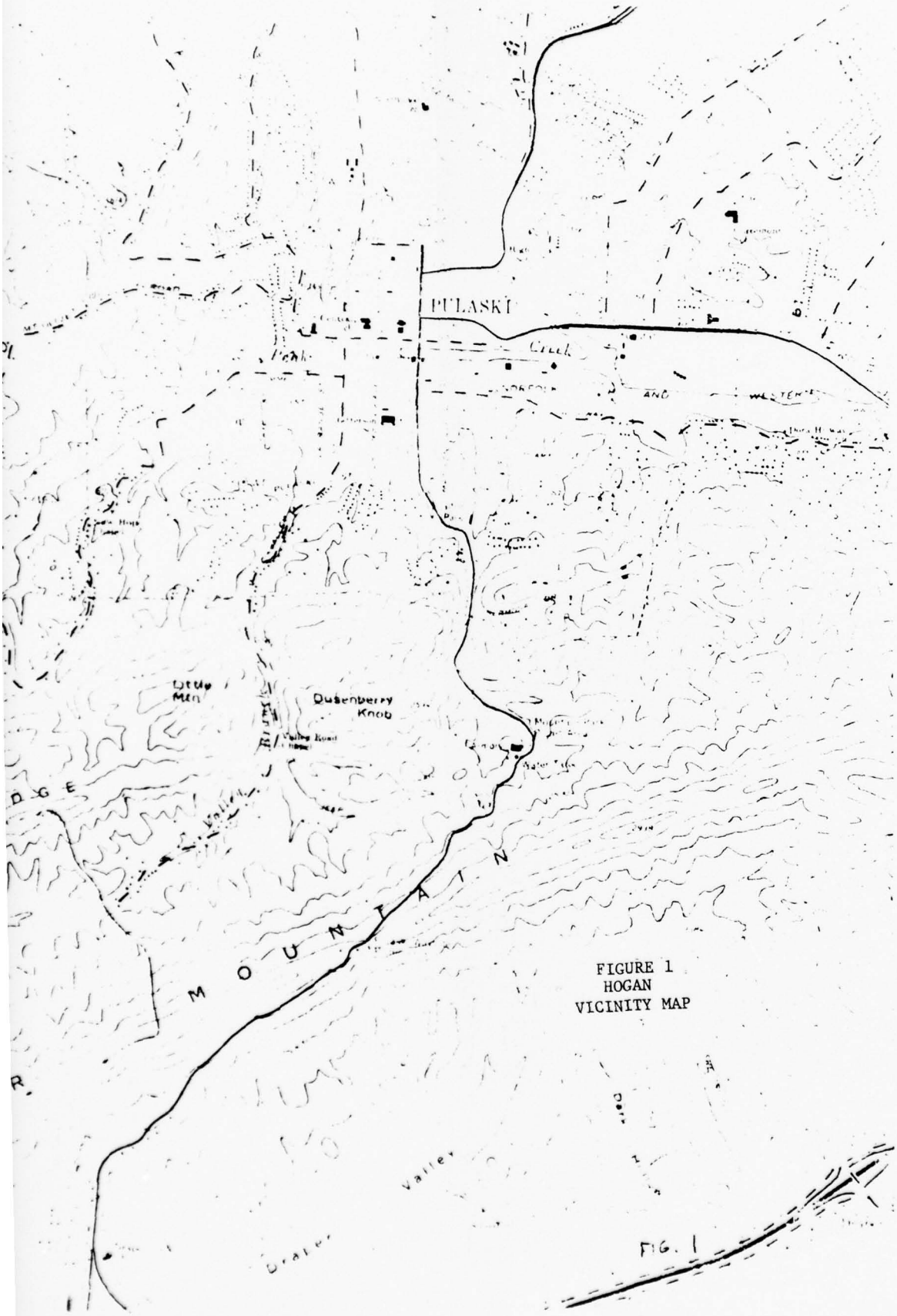



FIGURE 1
HOGAN
VICINITY MAP

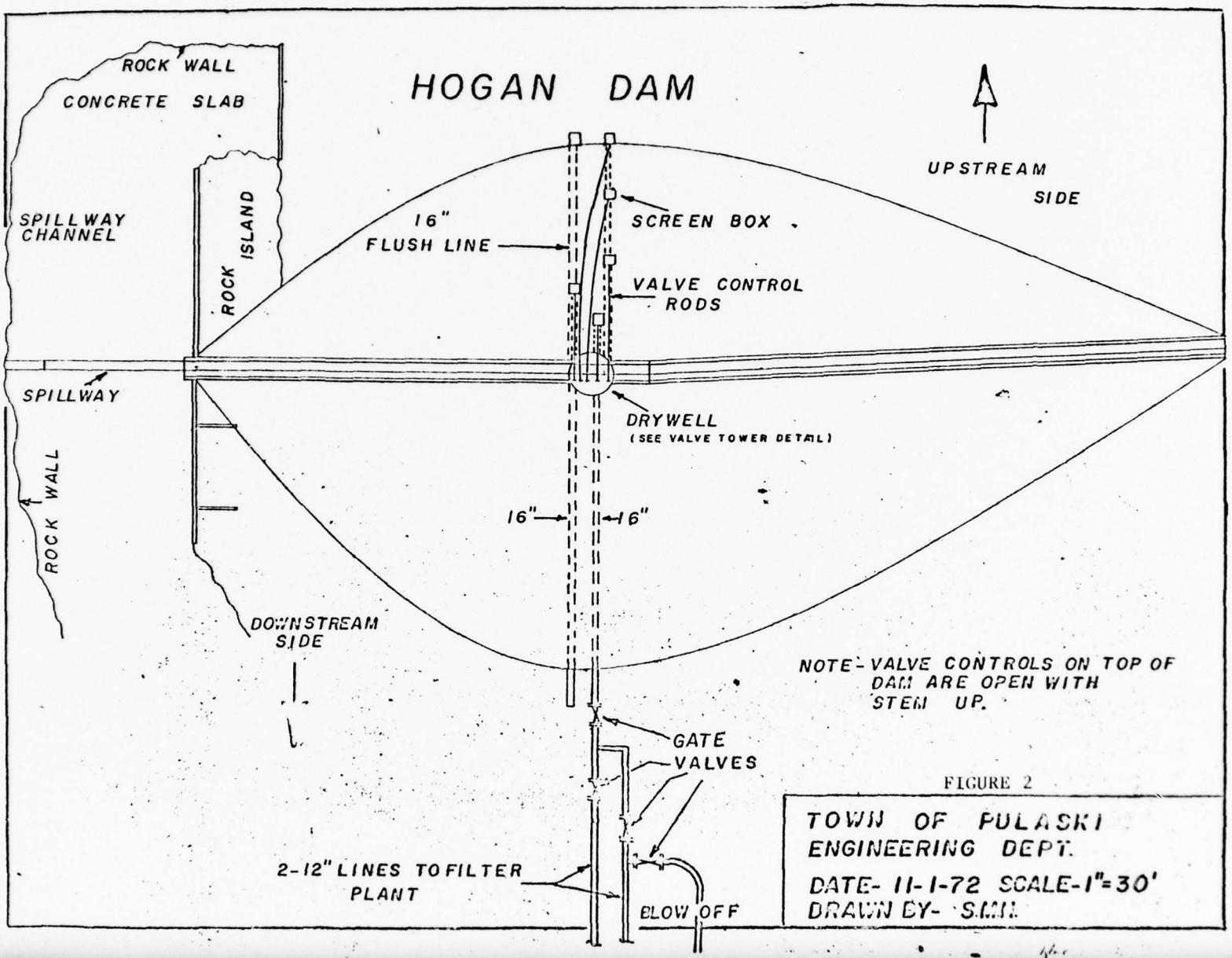

HOGAN DAM
ROCK WALL
CONCRETE SLAB
SPILLWAY CHANNEL
ROCK ISLAND
16" FLUSH LINE
SCREEN BOX
VALVE CONTROL RODS
UPSTREAM SIDE
SPILLWAY
DRYWELL
(SEE VALVE TOWER DETAIL)
ROCK WALL
16"
16"
DOWNSTREAM SIDE
NOTE- VALVE CONTROLS ON TOP OF DAM ARE OPEN WITH STEM UP.
GATE VALVES
2-12" LINES TO FILTER PLANT
BLOW OFF
TOWN OF PULASKI
ENGINEERING DEPT.
DATE- 11-1-72 SCALE-1"=30'
DRAWN BY- S.M.H.

FIGURE 2

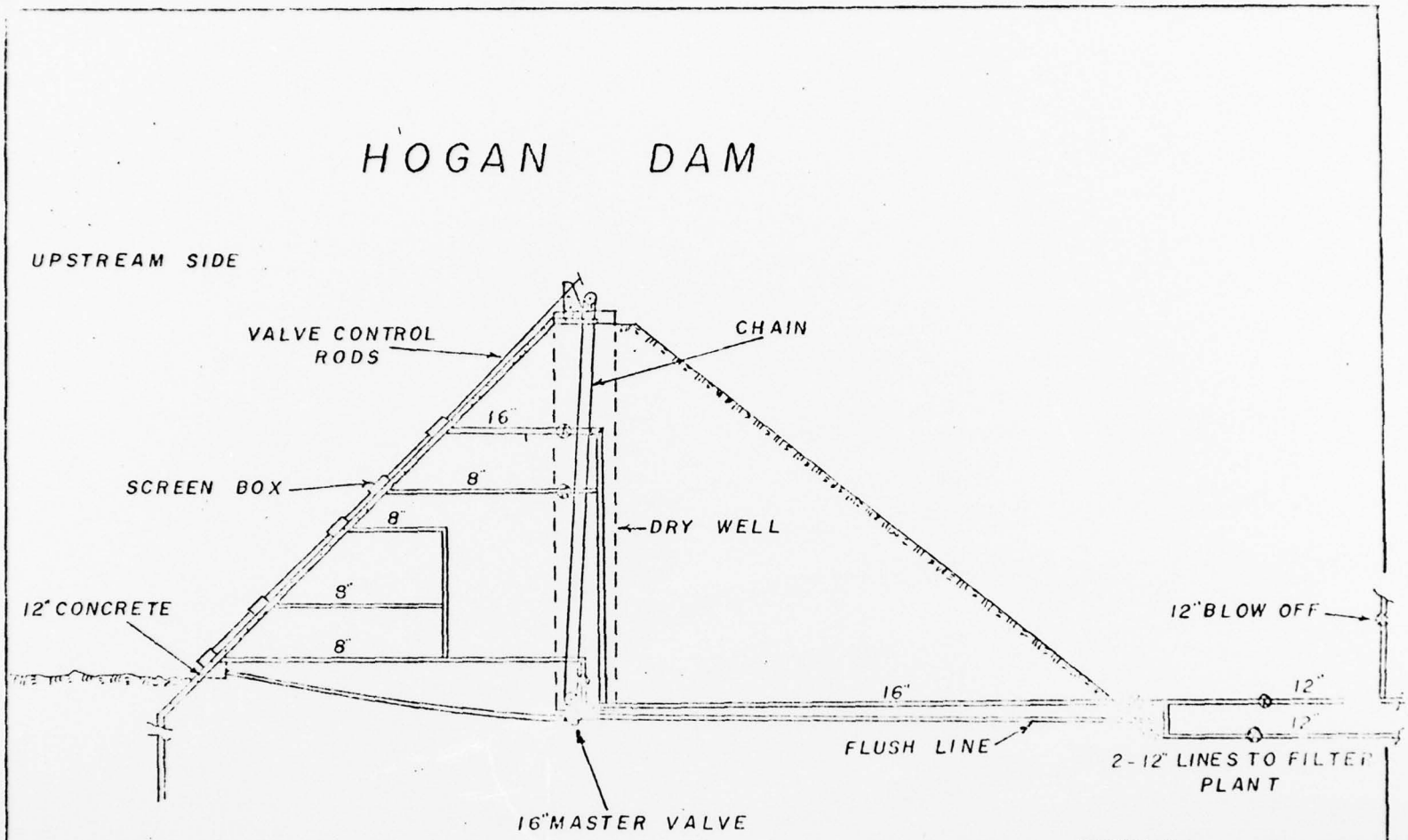



FIGURE 3.

HOGAN DAM
TOWN OF PULASKI
ENGINEERING DEPT.
DRAWN BY- S. M. H.
DATE- 11-1-72 SCALE- 1"=20'

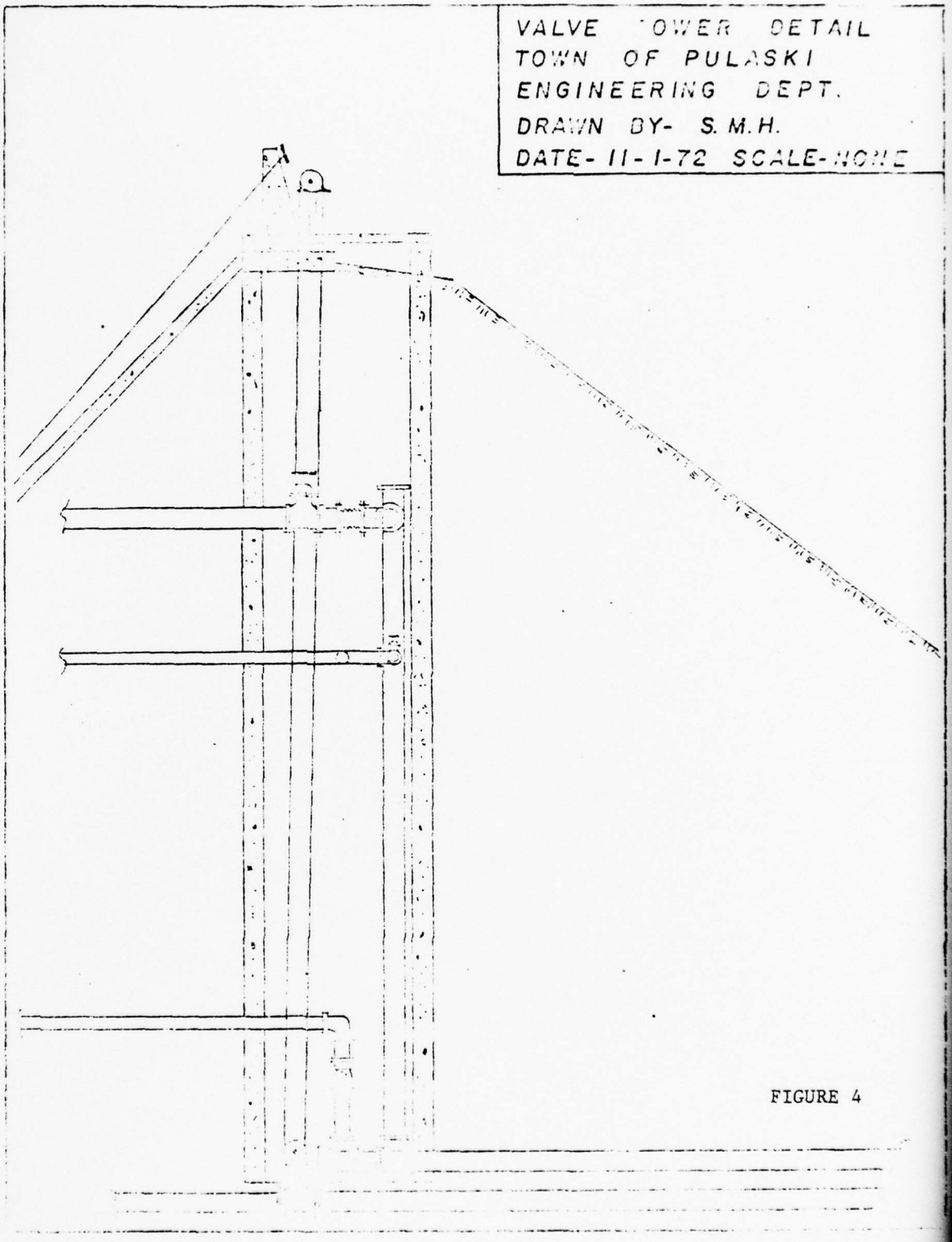

VALVE TOWER DETAIL
TOWN OF PULASKI
ENGINEERING DEPT.
DRAWN BY- S.M.H.
DATE- 11-1-72 SCALE-NONE

FIGURE 4

# APPENDIX II

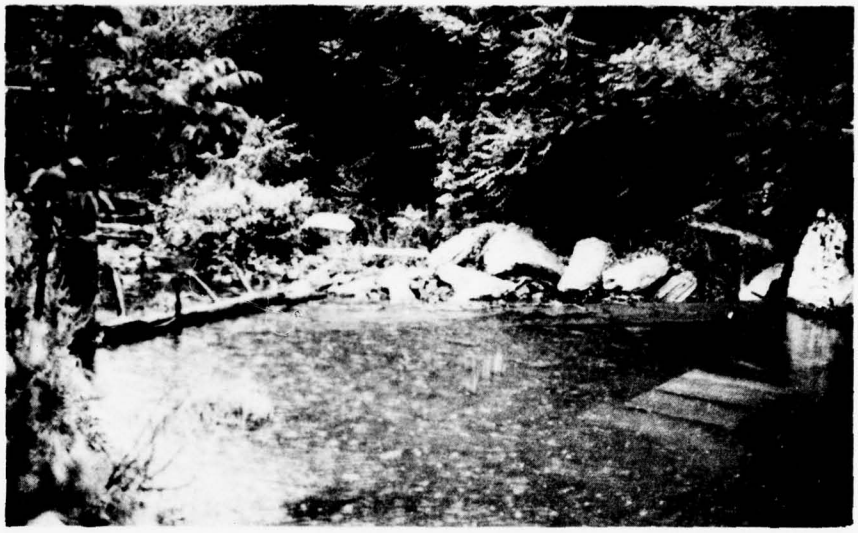
# PHOTOGRAPHS

May 1978

FACE OF DAM FROM DOWNSTREAM TOE

RESERVOIR OUTLET

May 1978



May 1978

VIEW OF SPILLWAY CREST, LOOKING DOWNSTREAM

May 1978

LOOKING UPSTREAM TOWARD SPILLWAY CREST

May 1978

HOGAN DAM AS IT APPEARED DURING ORIGINAL CONSTRUCTION

# APPENDIX III

# FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam: Hogan County: Pulaski State: Virginia Coordinators: Norfolk District Corps of Engineers

Date(s) Inspection: June 8, 1978 Weather: Light Rain Temperature: 70°F

Pool Elevation at Time of Inspection: 2153.4 feet m.s.l. Tailwater at Time of Inspection: 2095 ± m.s.l.

Gilbert Associates, Inc.
Inspection Personnel:

William J. Santamour

Thomas E. Roberts

Thomas W. Schreffler

Also Present:

Charles Boone - Virginia State Water Control Board

Ronald Coake - Town of Pulaski

Thomas W. Schreffler - Recorder

## EMBANKMENT



| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SURFACE CRACKS | None | |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE | None Observed. | |
| SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES | None Observed. | |
| VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST | The crest was straight and level. | |
| RIPRAP FAILURES | None | |
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | No erosion but some seepage on right abutment. | |
| ANY NOTICEABLE SEEPAGE | Seepage was observed on the slope below the spillway near the right abutment, at approximately the 2124 ft. elevation. The seepage was estimated at about 20 g.p.m. and was at 64°F. Surface water of the reservoir was 70°F and was 64°F at a depth approximately the same elevation as the seepage. E. F. Norton, caretaker at the dam, observed the seepage was above normal. | This should be monitored from now on using some type of flow measuring device. |

EMBANKMENT



| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| STAFF GAGE AND RECORDER | None. | |
| DRAINS | None. | |

## OUTLET WORKS



| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT | Outlet pipe has 16-inch diameter, pipe is very old but in serviceable condition. | |
| INTAKE STRUCTURE | Only visible portion of intake was valve operator and actuator rods. Mechanism turned easily and seemed to be in good condition. | |
| OUTLET STRUCTURE | None. | |
| OUTLET CHANNEL | Small creek leading away from the outlet was in a stable condition. | |
| EMERGENCY GATE | None. | |

UNGATED SPILLWAY

Sheet 1

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONCRETE WEIR | Weir has been lowered from previous position. Concrete walls are in good condition. Weir has the configuration of a broad crested weir. | |
| APPROACH CHANNEL | A level rock channel about 40 feet wide and 70 feet long, cut into the right abutment slope. It is in good condition. | |
| DISCHARGE CHANNEL | A rock channel about 35 feet wide and sloping at 1.3 percent. Channel is in good shape, but debris from the old spillway lies in the channel. | Concrete debris will obstruct the flow but it probably does not reduce the capacity of the spillway significantly. |
| BRIDGE AND PIERS | A small suspension footbridge crosses the spillway channel downstream of the crest. | The footbridge should not cause an obstruction to the flow. |

INSTRUMENTATION



| VISUAL EXAMINATION | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| MONUMENTATION/SURVEYS | None. | |
| OBSERVATION WELLS | None. | |
| WEIRS | None. | |
| PIEZOMETERS | None. | |
| OTHER | | |

RESERVOIR

Sheet 1

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SLOPES | Nothing unusual. | |
| SEDIMENTATION | None observed. | |

DOWNSTREAM CHANNEL



| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONDITION (OBSTRUCTIONS, DEBRIS, ETC.) | Channel is heavily wooded. | |
| SLOPES | Some talus forming along steep right slope. | |
| APPROXIMATE NO. OF HOMES AND POPULATION | Very few homes are below the dam for about one mile until Hogan Creek runs into Peak Creek. About 20 homes are along Peak Creek for about one mile and then the creek runs through the town of Pulaski. | |

# APPENDIX IV

# INSPECTION REPORTS

WILEY & WILSON
ENGINEERS · ARCHITECTS · PLANNERS
LYNCHBURG - RICHMOND

2310 LANGHORNE ROAD
LYNCHBURG, VA. 24501
703-847-9182

FOUNDERS
E. C. WILEY, PE 1870-1940
E. J. P. WILSON, PE 1884-1961

PARTNERS
W. M. JOHNSON, PE, CP — J. R. BOOTON, PE
E. J. P. WILSON, JR., PE — L. P. WADE, PE
T. R. LEACHMAN, AIA — W. M. GREENWOOD, PE

CONSULTANT — E. B. BOYNTON, PE
RETIRED — W. E. ROYALL, PE

ASSOCIATES
C. J. SIEGRIST, JR., PE
R. C. DODL, JR., PE
T. E. HALL, JR., PE — C. M. MITCHELL, JR., PE
R. C. JONES, PE — W. A. STUART, II, PE
B. G. WATKINS, JR., PE — W. D. WRIGHT, PE
G. L. PAGE, JR., PE — R. F. JEMPRIES, PE
M. K. SHELTON, AIA — L. D. AUSTIN, PE
C. M. PARKER, PE — J. W. MILLER, PE
T. J. ETHERTON, JR., AIA — KENT EVANS, PE
N. L. LYTTON, AIA — D. H. JONES, PE

October 9, 1972

Do Ronnie Cook

Mr. J. E. Marshall
Town Manager
Pulaski, Virginia

Re: Investigation of Hogan Dam
Comm. No. 2148

Dear Mr. Marshall:

This letter report contains the results of an investigation of Hogan Dam by representatives from Wiley & Wilson.

The condition of the concrete on the face of the dam is good. The valves and piping inside of the valve tower are being repaired and from all appearances, everything can be restored to working order. The five slide gates on the face of the dam are working satisfactorily and do not need to be replaced. New screens should be provided for all gates as well as gate actuator rods. The interconnecting piping between the gates and the valve tower should be thoroughly cleaned. 2ND FLOOR BOTTOM WILL NOT WORK

There is approximately 3 feet of mud and silt adjacent to the bottom of the upstream face of the dam. We estimate 1000 cu. yds. of material have been deposited immediately adjacent to the lowermost gate. This material should be removed before the reservoir is filled again. We suggest a clam shell bucket be used for cleaning operations and recommend that all mud and silt within 100 ft. of the toe of the dam be removed.

All slide gates had been numbered for identification prior to our investigation. These numbers are used herein to describe the location and condition of various components of the dam. Slide Gate No. 4 is approximately 10 ft. off the bottom of the dam and is typical of all of the shear gates. The screen covering this gate has rusted away and a new screen COMPLETED should be installed in its place. New screens should be installed over the COMPLETE other gates also. The actuator rods connecting each gate to the valve stand on top of the dam are badly rusted and the connector bolts for the various sections of rod are almost entirely rusted away. Therefore, new rods and new connections should be installed before the reservoir is filled again. COMPLETED Concrete below Gate No. 2 is good. From Gate No. 2 up the concrete is badly deteriorated in spots. There is a bad spall area approximately 10 feet above and to the west of Gate No. 1 as viewed from the face of the dam. This area should be repaired before the reservoir is filled again. COMPLETED

A line of wooden panels extends across the dam at the same elevation as Gate No. 1. Gunnite was probably pumped behind the face of the dam when the height of the dam was extended at some time in the past. The wooden panels should be left intact. These panels should have no effect on the stability or watertightness of the dam.

New valve operator chains are being installed in the valve tower. The stem extensions beyond the valve wheels on the various slide gates are as follows: COMPLETED

Gate No. 3 - 1 ft. 2 in. when fully open. 10"

Gate No. 1 - 1 ft. 6 in. when fully open. 16"

Gate No. 4 - 1 ft. 2 in. when fully open. 10"

Gate No. 5 - 1 ft. 2 in. when fully open. 10"

Gate No. 2 - 1 ft. 6 in. when fully open. 16"

The bedrock in contact with the northeast face of the dam and immediately adjacent to the spillway is, as Dr. Cooper reported in his investigations of May, 1970, contorted and fractured. However, the particular area where seepage through the bedrock and around the dam was occurring when he made his investigations could not be identified. Since the bedrock covers an extensive area along the side of the reservoir and the spillway has been lowered by approximately 6-1/2 feet, it does not appear practical, as was suggested in Dr. Cooper's report, to cover the bedrock with a concrete blanket to prevent the small amount of seepage which may occur when the reservoir is filled again. Should a significant amount of seepage take place after the reservoir is filled, the bedrock could be grouted with concrete during seasonal drawdown of the water level in the reservoir.

It is recommended that a blow-off valve and tee be installed in the 12" line directly below the dam to provide a means of cleaning the transmission mains after they are put back into service. One of the 12" lines already has a blow off valve and was used to drain the reservoir. The other blow-off valve would also be useful during draining operations and for periodic cleaning.

Repairs to the spillway have been made in accordance with the recommendations contained in the report submitted to the Town of Pulaski by Wiley & Wilson in September, 1970. That is, the spillway capacity has been increased by removing that section of the wall installed in 1946. Also, a retaining wall has been installed along the side of the spillway channel to prevent water from flowing across the back of the dam and eroding the rock backfill away during periods of high water.

It is our recommendation that record copies be prepared of the piping and valve layout in the valve tower and of the location of the slide gates on the face of the dam.

We agree with the suggestion of the Owner that the screen covering the slide gates can be cleaned by installing high pressure lines. The lines could be attached to the face of the dam using brackets and anchor bolts. A quick disconnect could be supplied for hook-up to a high pressure water pump for periodic cleaning of the screen(s).

It is our understanding that gravity flow from Hogam Dam to the filter plant increased by 50% to a maximum of 750,000 gallons per day when an obstruction to the lowermost slide gate was removed. We were also informed that prior to draining the reservoir and removing the obstruction, only 500,000 gallons per day was being transmitted to the filter plant from Hogan Reservoir.

As a result of our investigation, we conclude that Hogan Dam and Reservoir can be used to advantage by the Town of Pulaski and will continue to be a valuable asset in the overall water system serving the community.

It is our understanding that the water consumption in Pulaski and the surrounding area, notably in the Town of Dublin, has increased by approximately one half million gallons per day over the past two years. As a result of this increase in consumption, it is our recommendation that the Town of Pulaski authorize us to begin the preparation of plans and specifications to high rate their water filter plant. These plans and specifications will take approximately eight months for us to complete.

Should you need additional information regarding the investigation of Hogan Dam or on any aspect of the overall water report submitted by Wiley & Wilson in 1970, please do not hesitate to contact us.

Sincerely yours,

WILEY & WILSON

James C. May, Jr., PE

JCM:jn

bc: R. C. Dodl, Jr., PE

WILEY & WILSON, INC.
A PROFESSIONAL CORPORATION
ENGINEERS · ARCHITECTS · PLANNERS
LYNCHBURG – RICHMOND – VIRGINIA BEACH

2310 LANGHORNE ROAD
P. O. BOX 877
LYNCHBURG, VA. 24505
804-847-9132

FOUNDERS
E. C. WILEY, PE 1870-1943
E. J. P. WILSON, PE 1884-1961

DIRECTORS
W. M. JOHNSON, PE, CP
T. R. LEACHMAN, AIA
J. R. BOOTON, PE
L. P. WADE, PE
W. M. GREENWOOD, PE

CONSULTANT
E. B. BOYNTON, PE

RETIRED
W. E. ROYALL, PE

OFFICERS
G. L. PAGE, JR., PE
C. M. PARKER, PE
S. G. WATKINS, JR., PE
KENT EVANS, JR., PE

ASSOCIATES
C. J. SIEGRIST, JR., PE
R. C. DODL, JR., PE
T. E. HALL, JR., PE
R. C. JONES, PE
M. K. SHELTON, AIA
T. J. ETHERTON, JR., AIA
H. L. LYTTON, AIA
C. H. MITCHELL, JR., PE
W. A. STUART, II, PE
W. D. WRIGHT, PE
R. P. JEFFRIES, PE
I. D. AUSTIN, PE
D. M. JONES, JR., PE
O. E. CRAFT, JR., PE
W. P. CLINE, PE
S. T. THOMPSON, JR., PE
J. L. THOMPSON, PE
A. L. NICHOLS, JR., PE
W. B. NOLEN, PE
W. H. CLINGENPEEL, PE
M. K. JONES, JR., PE
C. H. BARNES, JR., AIP
D. P. MANNING, PE
C. W. BURTON, PE
P. R. MAYS, PE
R. G. ROBERSON, PE
J. K. SPENCER, III, PE
W. A. PASTABEND, PE
J. B. STEADMAN, PE
J. C. PAGE, RA
R. A. LEMON, PE

July 21, 1977

Mr. J. E. Marshall
Town Manager
Town of Pulaski
Municipal Building
Pulaski, Virginia 24301

Attn: Mr. Ron Coake

Re: Hogan & Gatewood Dam Inspection
W&W Comm. No. 7127

Gentlemen:

This is a report of our inspection of Hogan and Gatewood Dam as authorized in your letter of March 16, 1977.

The purpose of this inspection and report is to identify areas of the dams which have deteriorated and recommend needed repairs. Additionally, we are including an estimate of the cost to repair the defects in the dams.

Both dams were visually inspected June 17, 1977. We inspected and photographed all of both structures which were exposed above the water line and above grade. The upstream face of each dam was inspected at the water line with the use of a boat. Embankments adjacent to both dams were inspected by walking over the area and looking for leaks and seepage.

In addition to the field inspection, we have reviewed the original plans for Hogan and Gatewood Dams as well as the previous inspection report dated September 1970.

Hogan Dam Inspection:

Our observations of Hogan Dam were as follows:

1. Recent Construction - The spillway section has been lowered to its height prior to 1946. The southwest side of the

spillway channel has been walled with a counterforted type retaining wall to retain the water in the spillway channel. This counterforted wall appears to be in as-built condition. There is no evidence of any flood waters exceeding the capacity of the existing spillway channel.

2. Leaks - There is no evidence of significant leaks in this dam or its abutments. The only leak we were able to detect was on the left looking upstream approximately half way up the dam at the intersection of the dam and the abutment. This leak had a flow of approximately 1 to 2 gallons per minute.

3. Erosion - No erosion is in evidence on any part of the dam. Additionally, the spillway streambed appears to contain the overflow adequately with no significant erosion.

4. Deteriorated Concrete - The top of the dam which is exposed to view above the spillway crest shows some deterioration near the upstream water line. The concrete in these areas has been previously patched. Now, the patched areas are beginning to deteriorate and should be replaced. There is no evidence of any leaks through this concrete wall section.

5. Drains - The drain pipe at the base of the dam is discharging a flow that we estimate to be greater than 20 gallons per minute.

6. Valve Operators - The water intake valve operators appear to be in good repair. We did not, however, attempt to operate any of the valves.

7. Water Level - The water level in the dam was up to the crest of the spillway, but without any water flowing over the spillway.

Recommendations:

We recommend that the deteriorated concrete just above the water line on the upstream face of the dam be replaced. The defective material should be replaced with cast-in-place concrete bonded with epoxy. We estimate the cost for replacing the defective concrete to be approximately $6,700.

Gatewood Dam Inspection:

Our observations of the Gatewood Dam were as follows:

1. Water Level - The water level in the dam was approximately 2 feet below the normal spillway crest.

2. Leaks @ Abutments - Two leaks exist in the abutment area of this dam, neither are significant. One leak occurs at the southwest edge of the streambed at the toe of the dam. We estimate that this leak exceeds 10 gallons per minute. From the existing records and from the memory of those in our offices who have previously worked on the dam, it appears that this leak has not increased in volume. At the northeast abutment area there is a small flow of water seeping out of the bedrock at the rate of approximately 2 gallons per minute. This leak is near the intersection of the dam and the bedrock at approximately 10 to 15 feet below the top of the dam.

3. Leaks in Concrete - Several small leaks are coming directly through the concrete dam primarily at construction joints. We were able to count at least five leaks coming through the dam at various elevations which had enough flow in them to reach the tailwater before the flow could evaporate. More than this number of leaks exist elsewhere in the dam which dry up before reaching the tailwater. There is evidence of numerous previous small leaks similar to these that currently exist that have dried up and are only efflorescent stains on the dam. Mr. Leroy Early, Director of Public Works, informed me that during the past winter when the temperatures were down below zero that a leak developed in the dam approximately half way up near the northeast end of the spillway. This leak was a stream of water approximately 2" in diameter which jetted out of the dam for a distance of approximately 8 feet. Currently this leak has sealed itself and is inactive. None of these leaks are significant at this time; however, when other grouting is done on this structure it would be expedient to seal these leaks.

4. Efflorescent Spots - We tested several of the white efflorescent spots on the downstream face of the dam where leaks had previously occurred and have sealed themselves off. In all of the efflorescent spots which we checked there was sound concrete underneath and no indication of any significant deterioration of the concrete surface.

5. Deteriorated Concrete - As mentioned in the previous reports, there is considerable deterioration of the concrete surface in the third lift from the crest of the spillway. This deterioration begins immediately northeast of the normal spillway crest and extends all the way to the northeast abutment. The spalling reaches a maximum depth of approximately 5". This concrete was apparently of poor quality and has deteriorated due to weathering.

6. Intake Structure - The water intake valve operators appear to be well maintained. The concrete surface of the roof slab has weathered and spalled to a depth of approximately 2".

7. Erosion - There was no visible evidence of erosion anywhere around this dam. Mr. Leroy Early informed me that during the recent floods early this spring, water cascaded over the dam and shot downstream as much as 50'. During this torrential rain, he said that there was erosion of the streambed at the toe of the dam in excess of 15' deep. Broken rocks from the streambed were thrown out of the creek and on to the adjacent banks. Subsequently, the broken rocks from the streambed were pushed back into the stream with front end loaders and leveled into the previous position. In our checking of the plans of the original structure, we find that the maximum depth of concrete here is approximately 5.5' below the top of the concrete toe. Any undercutting underneath the concrete toe of the dam would be significant.

Recommendations:

We make the following recommendations for repair of the Gatewood Dam:

1. Explore the streambed at the toe of the dam to identify the location of existing bedrock and the extent of undercutting of the toe of the dam, if any. Once the location of bedrock is located in this area, then an appropriate concrete apron can be designed and placed in the streambed. We recommend that any apron placed in this area be founded on bedrock.

2. The small leaks in the concrete section should be sealed off by drilling the dam from the top and grouting with a cement grout. Since these leaks are more active during the winter time than warmer months, we would suggest that consideration be given to grouting the dam while temperatures are low. This would allow for identification of more leaks as well as allowing the cracks to be sealed at their maximum size.

3. Resurface the top of the water intake structure slab with a high quality concrete topping bonded with epoxy. The deteriorated concrete should be chipped down to firm material and replaced on a slope such that the surface will drain naturally and will not collect water.

4. Grout the leaks in the abutments with a cement grout. We feel that the leak at the southwest stream edge can be sealed by forcing grout into the outlet. The leak at the northeast abutment may be sealed while grouting the deteriorated concrete outlined in item number 5 by drilling down into the bedrock.

5. Grout the deteriorated concrete lift (3rd lift below spillway @ northeast end) and replace the deteriorated concrete surface with epoxy bonded cast-in-place concrete. The grouting should precede the resurfacing of the downstream face. The maximum repair area appears to be approximately 120' x 5'.

We estimate that the grouting and repair of the concrete surfaces at Gatewood Dam could cost approximately $50,000. A lightly reinforced concrete apron in the streambed 2' thick and with 9000 square feet of surface could cost as much as $50,000.

The cost estimate of repair for both dams should be considered as an order of magnitude cost only and are based on our visual inspection.

Should you decide to proceed with the repairs, we will be happy to prepare the plans and specifications required. We thank you for the opportunity to have been of service to the Town of Pulaski again.

If you have any questions about this report or if we can be of further assistance, please let us know.

Very truly yours,

WILEY & WILSON, INC.

W. B. Nolen

W. B. Nolen, PE

WBN/bc

cc: R. C. Dodl

# APPENDIX V

# REFERENCES

## APPENDIX V

## REFERENCES


1. Recommended Guidelines for Safety Inspection of Dams, (Washington, D.C., Department of the Army, Office of the Chief of Engineers).

2. HEC-1 Flood Hydrograph Package," (Hydrologic Engineering Center, U.S. Army Corps of Engineers, January 1973).

3. Design of Small Dams, (U.S. Department of the Interior, Bureau of Reclamation, Second Edition, 1973).

4. "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian," Hydrometeorological Report No. 33, (U.S. Weather Bureau, April 1956).

5. "Rainfall Frequency Atlas of the United States," Technical Paper No. 40, (U.S. Weather Bureau, May 1961).

# APPENDIX VI

# CONDITIONS

## APPENDIX VI

## CONDITIONS

This Report is based on a visual inspection of the dam, a review of available engineering data, and a hydrologic analysis performed during a Phase I investigation as set forth in the U.S. Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams and the contract between the U.S. Corps of Engineers and Gilbert Associates, Inc.

The foregoing inspection, review, and analysis are by their nature limited in scope. It is possible that conditions exist which are hazardous, or which might in time develop into safety hazards, that are not detectable by this inspection, review, and analysis. Accordingly, Gilbert Associates, Inc. cannot and does not warrant or represent that conditions which are hazardous, or which may in time develop into safety hazards, do not exist.